

WHAT IS CLAIMED IS:

- 1 1. A method for maintaining consistency of data, comprising:
2 copying one or more blocks of data identified by a first structure to form a
3 consistent set of data; and
4 while not acknowledging completion of write requests to any blocks of data,
5 creating a second structure, wherein the second structure indicates which blocks of data
6 are modified while the consistent set of data is being formed.

- 1 2. The method of claim 1, further comprising:
2 after creating the second structure,
3 allowing completion of write requests that had not been acknowledged; and
4 processing new write requests, with modifications to blocks of data being
5 recorded using the second structure.

- 1 3. The method of claim 2, wherein the second structure includes indicators,
2 and wherein each indicator indicates whether a corresponding block of data was modified
3 while the consistent set of data is being formed, further comprising:
4 receiving a new write request for a block of data; and
5 if modifications to blocks of data are being recorded using the second structure and
6 an indicator corresponding to the block of data is set in the first structure to indicate that
7 the block of data is to be copied,
8 sending an image of the block of data in cache to remote storage;
9 setting the corresponding indicator in the first structure to indicate that the
10 block is not to be copied; and
11 processing the new write request.

1 4. The method of claim 2, wherein the second structure includes indicators,
2 and wherein each indicator indicates whether a corresponding block of data was modified
3 while the consistent set of data is being formed, further comprising:
4 receiving a new write request for a block of data; and
5 if modifications to blocks of data are being recorded using the second structure, an
6 indicator corresponding to the block of data is set in the first structure to indicate that the
7 block of data is to be copied, and the block of data has a new image in cache, applying the
8 new write request to the new image.

1 5. The method of claim 4, further comprising:
2 if at least one of modifications to blocks of data are not being recorded using the
3 second structure and the indicator corresponding to the block of data is not set in the first
4 structure to indicate that the block of data is to be copied, processing the new write request
5 normally.

1 6. The method of claim 4, further comprising:
2 if modifications to blocks of data are being recorded using the second structure, an
3 indicator corresponding to the block of data is set in the first structure to indicate that the
4 block of data is to be copied, and the block of data does not have a new image in cache,
5 allocating a new image for the block of data; and
6 applying the new write request to the new image.

1 7. The method of claim 4, further comprising:
2 sending an image of a block of data in cache to remote storage; and
3 if modifications to blocks of data are being recorded using the second structure and
4 the block of data has an image in the cache,
5 discarding the image in the cache; and

6 setting the corresponding indicator in the first structure to indicate that the
7 block is not to be copied.

1 8. A method for asynchronous copy, comprising: /
2 updating indicators in a first structure for one or more blocks of data, wherein each
3 indicator in the first structure indicates whether a corresponding block of data was
4 modified since the block of data was last sent to remote storage; and
5 while copying the blocks of data identified by the indicators in the first structure as
6 having been modified since the blocks of data were last sent to remote storage, updating
7 indicators in a second structure for the one or more blocks of data, wherein each indicator
8 in the second structure indicates whether a corresponding block of data was modified
9 while a consistent set of data is being formed.

1 9. The method of claim 8, further comprising:
2 after copying a block of data identified by an indicator in the first structure to the
3 remote storage, updating the indicator to indicate that the block of data is synchronized
4 with the remote storage.

1 10. The method of claim 8, further comprising:
2 after receiving a run command,
3 resuming acceptance of write requests from a host;
4 updating indicators in the second structure instead of in the first structure;
5 and
6 copying the blocks of data identified by the indicators in the first structure
7 as having been modified since the blocks of data were last sent to remote storage.

1 11. An article of manufacture for maintaining consistency of data, wherein the
2 article of manufacture causes operations, the operations comprising:
3 copying one or more blocks of data identified by a first structure to form a
4 consistent set of data; and
5 while not acknowledging completion of write requests to any blocks of data,
6 creating a second structure, wherein the second structure indicates which blocks of data
7 are modified while the consistent set of data is being formed.

1 12. The article of manufacture of claim 11, wherein the operations further
2 comprise:
3 after creating the second structure,
4 allowing completion of write requests that had not been acknowledged; and
5 processing new write requests, with modifications to blocks of data being
6 recorded using the second structure.

1 13. The article of manufacture of claim 12, wherein the second structure
2 includes indicators, wherein each indicator indicates whether a corresponding block of
3 data was modified while the consistent set of data is being formed, and wherein the
4 operations further comprise:
5 receiving a new write request for a block of data; and
6 if modifications to blocks of data are being recorded using the second structure and
7 an indicator corresponding to the block of data is set in the first structure to indicate that
8 the block of data is to be copied,
9 sending an image of the block of data in cache to remote storage;
10 setting the corresponding indicator in the first structure to indicate that the
11 block is not to be copied; and
12 processing the new write request.

1 14. The article of manufacture of claim 12, wherein the second structure
2 includes indicators, wherein each indicator indicates whether a corresponding block of
3 data was modified while the consistent set of data is being formed, and wherein the
4 operations further comprise:
5 receiving a new write request for a block of data; and
6 if modifications to blocks of data are being recorded using the second structure, an
7 indicator corresponding to the block of data is set in the first structure to indicate that the
8 block of data is to be copied, and the block of data has a new image in cache, applying the
9 new write request to the new image.

1 15. The article of manufacture of claim 14, wherein the operations further
2 comprise:
3 if at least one of modifications to blocks of data are not being recorded using the
4 second structure and the indicator corresponding to the block of data is not set in the first
5 structure to indicate that the block of data is to be copied, processing the new write request
6 normally.

1 16. The article of manufacture of claim 14, wherein the operations further
2 comprise:
3 if modifications to blocks of data are being recorded using the second structure, an
4 indicator corresponding to the block of data is set in the first structure to indicate that the
5 block of data is to be copied, and the block of data does not have a new image in cache,
6 allocating a new image for the block of data; and
7 applying the new write request to the new image.

1 17. The article of manufacture of claim 14, wherein the operations further
2 comprise:
3 sending an image of a block of data in cache to remote storage; and
4 if modifications to blocks of data are being recorded using the second structure and
5 the block of data has an image in the cache,
6 discarding the image in the cache; and
7 setting the corresponding indicator in the first structure to indicate that the
8 block is not to be copied.

1 18. An article of manufacture for asynchronous copy, wherein the article of
2 manufacture causes operations, the operations comprising: ✓
3 updating indicators in a first structure for one or more blocks of data, wherein each
4 indicator in the first structure indicates whether a corresponding block of data was
5 modified since the block of data was last sent to remote storage; and
6 while copying the blocks of data identified by the indicators in the first structure as
7 having been modified since the blocks of data were last sent to remote storage, updating
8 indicators in a second structure for the one or more blocks of data, wherein each indicator
9 in the second structure indicates whether a corresponding block of data was modified
10 while a consistent set of data is being formed.

1 19. The article of manufacture of claim 18, wherein the operations further
2 comprise:
3 after copying a block of data identified by an indicator in the first structure to the
4 remote storage, updating the indicator to indicate that the block of data is synchronized
5 with the remote storage.

1 20. The article of manufacture of claim 18, wherein the operations further
2 comprise:
3 after receiving a run command,
4 resuming acceptance of write requests from a host;
5 updating indicators in the second structure instead of in the first structure;
6 and
7 copying the blocks of data identified by the indicators in the first structure
8 as having been modified since the blocks of data were last sent to remote storage.

1 21. A system for maintaining consistency of data, comprising: ✓
2 means for copying one or more blocks of data identified by a first structure to form
3 a consistent set of data; and
4 means for, while not acknowledging completion of write requests to any blocks of
5 data, creating a second structure, wherein the second structure indicates which blocks of
6 data are modified while the consistent set of data is being formed.

1 22. The system of claim 21, further comprising:
2 after creating the second structure,
3 means for allowing completion of write requests that had not been
4 acknowledged; and
5 means for processing new write requests, with modifications to blocks of
6 data being recorded using the second structure.

1 23. The system of claim 22, wherein the second structure includes indicators,
2 and wherein each indicator indicates whether a corresponding block of data was modified
3 while the consistent set of data is being formed, further comprising:
4 means for receiving a new write request for a block of data; and

5 if modifications to blocks of data are being recorded using the second structure and
6 an indicator corresponding to the block of data is set in the first structure to indicate that
7 the block of data is to be copied,
8 means for sending an image of the block of data in cache to remote storage;
9 means for setting the corresponding indicator in the first structure to
10 indicate that the block is not to be copied; and
11 means for processing the new write request.

1 24. The system of claim 22, wherein the second structure includes indicators,
2 and wherein each indicator indicates whether a corresponding block of data was modified
3 while the consistent set of data is being formed, further comprising:
4 means for receiving a new write request for a block of data; and
5 means for, if modifications to blocks of data are being recorded using the second
6 structure, an indicator corresponding to the block of data is set in the first structure to
7 indicate that the block of data is to be copied, and the block of data has a new image in
8 cache, applying the new write request to the new image.

1 25. The system of claim 24, further comprising:
2 means for, if at least one of modifications to blocks of data are not being recorded
3 using the second structure and the indicator corresponding to the block of data is not set in
4 the first structure to indicate that the block of data is to be copied, processing the new
5 write request normally.

1 26. The system of claim 24, further comprising:
2 if modifications to blocks of data are being recorded using the second structure, an
3 indicator corresponding to the block of data is set in the first structure to indicate that the
4 block of data is to be copied, and the block of data does not have a new image in cache,

5 means for allocating a new image for the block of data; and
6 means for applying the new write request to the new image.

1 27. The system of claim 24, further comprising:
2 means for sending an image of a block of data in cache to remote storage; and
3 if modifications to blocks of data are being recorded using the second structure and
4 the block of data has an image in the cache,
5 means for discarding the image in the cache; and
6 means for setting the corresponding indicator in the first structure to
7 indicate that the block is not to be copied.

1 28. A system for asynchronous copy, comprising: ✓
2 means for updating indicators in a first structure for one or more blocks of data,
3 wherein each indicator in the first structure indicates whether a corresponding block of
4 data was modified since the block of data was last sent to remote storage; and
5 means for, while copying the blocks of data identified by the indicators in the first
6 structure as having been modified since the blocks of data were last sent to remote storage,
7 updating indicators in a second structure for the one or more blocks of data, wherein each
8 indicator in the second structure indicates whether a corresponding block of data was
9 modified while a consistent set of data is being formed.

1 29. The system of claim 28, further comprising:
2 means for, after copying a block of data identified by an indicator in the first
3 structure to the remote storage, updating the indicator to indicate that the block of data is
4 synchronized with the remote storage.

1 30. The system of claim 28, further comprising:
2 after receiving a run command,
3 means for resuming acceptance of write requests from a host;
4 means for updating indicators in the second structure instead of in the first
5 structure; and
6 means for copying the blocks of data identified by the indicators in the first
7 structure as having been modified since the blocks of data were last sent to remote storage.